Docket No. 99.056.TAP

METHOD AND SYSTEM FOR EMISSION SUPPRESSION IN DETECTION OF DATA CARTRIDGE LABELS

Background of the Invention

1. Field of the Invention

The present invention relates generally to data storage subsystems, and more particularly to a robotic system and method for identifying data cartridge locations with reduced electromagnetic emissions in a data cartridge library system.

2. Description of Related Art

A typical digital data cartridge handling library includes number of columns of stacked bins containing data cartridges positioned around a centrally located manipulating arm with a cartridge grasping hand which can rotate, translate and elevate to position the hand in front of a particular bin containing the desired cartridge. The arrangement is sometimes called a "silo" arrangement, borrowing a term from the farming industry. The data cartridges may be optical data disks, tape cartridges or magnetic disc cartridges, depending on the type of recording apparatus involved. Typically, the data cartridges are data tape cartridges and the drive is a tape drive.

When the manipulating arm is properly positioned opposite a desired bin or cartridge slot in the desired column, the arm automatically extends and the hand grips the cartridge. The arm retracts, pulling the cartridge out of the bin. The arm then rotates, elevates, and moves the hand in or out to position the gripped cartridge into a cartridge drive apparatus such as a tape drive so that the data on the cartridge may be read or appropriately changed as required by the host computer system. When the operations requiring the cartridge to be in the drive are completed, the host computer then directs the manipulating arm to replace the cartridge in its assigned bin and then proceed with obtaining a next cartridge, if needed.

A CCD camera located on the hand periodically senses the location of the hand in order to precisely position the hand and provide location information feedback to the manipulator controller. This camera also has a linear array of LEDs arranged to project a line of red light to illuminate the tape cartridge bin markers as well as the identifying bar code labels on the cartridges. Since the LEDs and the camera are typically maintained on at all times, much of the electronics circuitry for camera control and signal processing is mounted on the hand with the camera. This component mass must be elevated, translated and rotated as part of the robot manipulator apparatus.

One of the byproducts of these data cartridge handling libraries is the production of unwanted noise. This noise, in particular, includes electromagnetic radiation (EMR) noise which can adversely affect other components and/or systems located nearby, such as peripheral devices, computers, video monitors, etc. Consequently, the cartridge libraries are typically shielded to prevent escape of the EMR or at least minimize the transmission of EMR.

One of the prime sources of unwanted EMR in these library systems originates with the electronic components located on the hand itself. Therefore significant amounts of material are utilized on the hand to effectively shield the surrounding environment from the EMR. This increases the size and mass of the hand and therefore the manipulator arm strength and mass must be appropriately sized in order to overcome inertial forces and produce the desired movements in the desired time periods in order to optimally minimize the time required for a "pick" or "put' operation to be performed. It is with respect to these and other considerations that the present invention has been made.

Summary of the Invention

The present invention is a system and method for use in a data cartridge handling library for reducing the emissions of electromagnetic radiation (EMR) from the data cartridge handling library. The method basically involves turning on the positioning camera located on the manipulator hand in the library silo only when an anticipated desired bin location is approached during an audit operation.

More particularly, the method in accordance with the present invention comprises storing cartridges in tape handling library storage bins, turning on the manipulator camera, performing an audit of all of the cartridges in the storage bins with the manipulator hand, storing the bin location coordinates for each bin containing a cartridge along with cartridge identification data in a database, turning off the camera, and subsequently retrieving cartridges from the bins by utilizing the bin location coordinates.

These and various other features as well as advantages which characterize the present invention will be apparent from a reading of the following detailed description and a review of the associated drawings.

Brief Description of the Drawings

Fig. **1** is a schematic representation of a cartridge library system including a host computer, data cartridge storage silo and a storage controller in accordance with a preferred embodiment of the present invention.

Fig. **2** is a block diagram of the hand manipulator storage controller microprocessors in one preferred embodiment of the present invention.

Fig. **3** is a process flow diagram of operations of the audit software routine in the preferred embodiment of the present invention shown in Fig. **2**.

Detailed Description of the Preferred Embodiment

FIG. **1** depicts an automated cartridge library system **100**. Operation of automated cartridge library system **100** is directed by a host computer **102**. Host computer **102** communicates with a library control unit (LCU) **112**. The operation of a robot arm **106** within a library storage module (LSM) **108** is governed by the library control unit (LCU) **112** which interprets signals from host computer **102** and provides appropriate signals to the robot manipulator arm **106** to control its motion and operation. Signals from host computer **102** control the handling and storage of tape cartridges within the library storage module **108**. Signals between host computer **102** and the library storage module **108** are conducted over conductors which are represented by the solid lines in FIG. **1**. Data to be written to a tape cartridge (not

shown in FIG. **1**) or read from a tape cartridge is communicated over data lines, represented by the dotted lines of FIG. **1**, through the tape control unit (TCU) **110**. TCU **110** controls the operation of each of the tape drives **104** associated with LSM **108**.

In general terms, when there is a need to read data from a tape cartridge in LSM **108**, robot arm **106**, in response to signals from the host computer **102**, retrieves the appropriate tape cartridge from a storage cell and inserts the tape cartridge in a tape drive **104**. Signals from host computer **102** through the TCU **110** then control the reading/writing of data from/to the tape cartridge.

As shown in block diagram form in Fig. **2**, the library control unit (LCU) **112** which controls the robot manipulator arm **106** has a main microprocessor **202**. The robot arm **106** has a robot manipulator hand microprocessor **204** and a camera imager microprocessor **206**, the latter two of which are physically located on the gripper hand of the robot arm **106**.

The main processor **202** provides a camera enable signal to the crystal oscillator **210** in the hand microprocessor **204**. When enabled, the crystal oscillator **210** provides a clock input to the camera clock generator **212**. The camera clock generator **212** in turn provides clock input and output signals **214** to the camera imager **216** in the camera imager microprocessor **206**. The main processor **202** also provides image exposure control, picture synchronization and pixel synchronization signals to the clock generator **212** via lines **218**, **220** and **222** respectively. When the camera clock generator **212** is turned on, the camera imager microprocessor **206** starts the camera and analog output signals are passed from the camera imager **206** via line **224** to a sample/hold circuit **226** and thence through buffers to the main computer microprocessor **202** via lines **228**.

Microprocessor **202** stores library cartridge identification data and position information in a database which may be located in the LCU **112**. In order to accurately position the hand of the manipulator arm **106** to retrieve a cartridge or place a cartridge in a particular bin, the LCU **104** must have accurate location information as well as cartridge identification information. This information is gathered initially through a software "Audit Subsystem" routine which reads and catalogues each and every bin location and its contents into the database in the

LCU **112**. This database is subsequently utilized by the LCU **112** to control the operation of the robot arm **106** during normal cartridge retrieval operations.

During the initial information gathering operation, or performance of the Audit Subsystem **303**, the robot manipulator **106** systematically drives to anticipated bin location and reads picture information identifying the exact bin location with the hand camera. The content of each bin is also read with the manipulator hand camera and associated with the location. This data is then stored for subsequent tape cartridge handling operations without the use of the hand camera.

Typically, the stored information only is utilized to place and retrieve cartridges from and to the bins without the aid of the robot manipulator hand camera. However, periodically, and whenever cartridge changes are made, the Audit Subsystem routine is invoked in order to add data to the database and/or verify the accuracy of hand manipulation or travel. Thus, during normal operation, the camera located on the manipulator arm is off and not used, thus minimizing any EMR emissions from the library.

Referring now to Fig. **3**, a flow diagram of the operational software steps in the Audit subsystem **300** is shown. The LCU **112** triggers the virtual Audit Subsystem **300** when tape cartridges are added or replaced, and periodically to verify the accuracy of hand operation. The virtual Audit Subsystem **300** transfers control to operation **301** where the Database is queried. If the Tape Label data is known then the Cell Contents Database **302** is returned to the LCU **112**. IF the Tape Label Data is not known then the Audit Subsystem **303** is called. When the Audit subsystem **303** is called, a request for a picture is issued on line **305** to the line scan camera software interface **304**. Control then transfers to operation **310** where the state of the camera is queried. If the camera is on, control transfers to operation **312** which provides a delay until the picture gathered is complete. The camera interface **304** then transfers control to operation **306** where data is accumulated for the picture. When sufficient data is accumulated, control transfers to operation **308** where the picture data is registered. When the picture is complete, control transfers back to the Line Scan Camera Software Interface operation **304** and thence via line **313** to the Audit subsystem **303** and the Tape Label Data is written to the Cell Contents Database **317**.

If the camera is not on in query operation **310**, control transfers to operation **314** where the camera is turned on. A Request for a Picture turns on the Camera Enable **208** to start the camera and its associated clocking. Control remains in operation **314** until a camera saturation condition is cleared, at which time control transfers to operation **312** as discussed in the previous paragraph. When the Label Data is known and there are no more requests for pictures the Line Scan Camera Software Interface **304** turns off the camera and its associated clocking.

The audit subroutine **303** described above is typically only invoked when the system is reset or upon opening or closing the doors into the unit. Otherwise the audit subroutine is invoked only when an error condition is detected such as cells being unexpectedly full or empty or the Get/Put call system stalls.

The above specification, examples and data provide a complete description of one embodiment of the method and the apparatus of the invention. Many variations of the invention will be readily apparent to those skilled in the art. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, all such modifications and variations are envisioned as being within the scope of the invention as defined by the following claims.